US009335661B2

(12) United States Patent
Kusukawa

(10) Patent No.: US 9,335,661 B2
(45) Date of Patent: May 10, 2016

(54) **DEVELOPING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SAME**

(71) Applicant: **KYOCERA Document Solutions Inc.**, Osaka (JP)

(72) Inventor: **Takashi Kusukawa**, Osaka (JP)

(73) Assignee: **KYOCERA Document Solutions Inc.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/824,905**

(22) Filed: **Aug. 12, 2015**

(65) **Prior Publication Data**

US 2016/0048094 A1 Feb. 18, 2016

(30) **Foreign Application Priority Data**

Aug. 18, 2014 (JP) 2014-165708

(51) **Int. Cl.**
G03G 15/08 (2006.01)
G03G 15/00 (2006.01)
G03G 15/095 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0891*** (2013.01); ***G03G 15/095*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/095; G03G 15/0891
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,494,400	B2	7/2013	Kashimoto et al.	
8,965,253	B2	2/2015	Kusukawa et al.	
2011/0229184	A1	9/2011	Kashimoto et al.	
2013/0209142	A1 *	8/2013	Kusukawa	G03G 15/081 399/274

FOREIGN PATENT DOCUMENTS

JP	H09-211974	A	8/1997
JP	2011-197285	A	10/2011
JP	2013-190767	A	9/2013

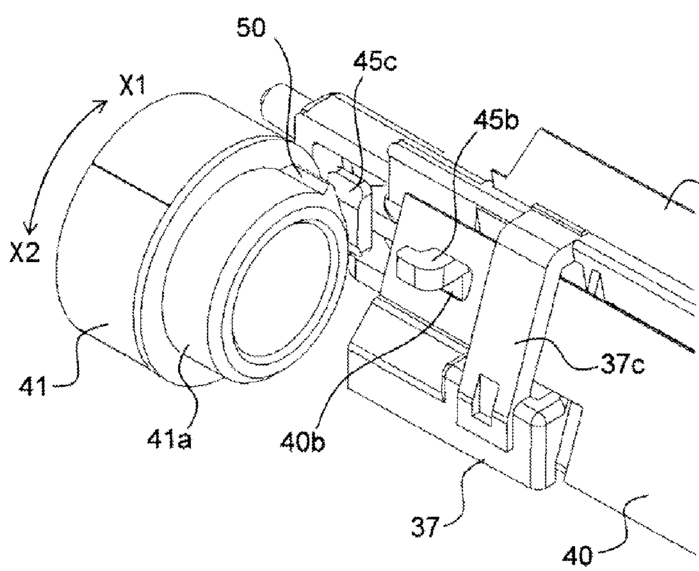
* cited by examiner

Primary Examiner — David Gray
Assistant Examiner — Michael Harrison
(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A developing device includes a development roller, a toner supply roller, a casing having an inner wall portion facing toward the development roller, a flexible film member, an urging member, a linkage member, and a linkage member driving mechanism. The flexible film member is disposed on the inner wall portion and has ends in a direction of an axis of the development roller that are opposite to each other. The urging member is connected with one of the ends of the film member and pulls the film member. The linkage member is connected with the other of the ends of the film member. The linkage member driving mechanism drives the linkage member in accompaniment to rotation of a gear to intermittently pull the film member, so that the film member reciprocates in directions parallel to the axis of the development roller.

13 Claims, 12 Drawing Sheets



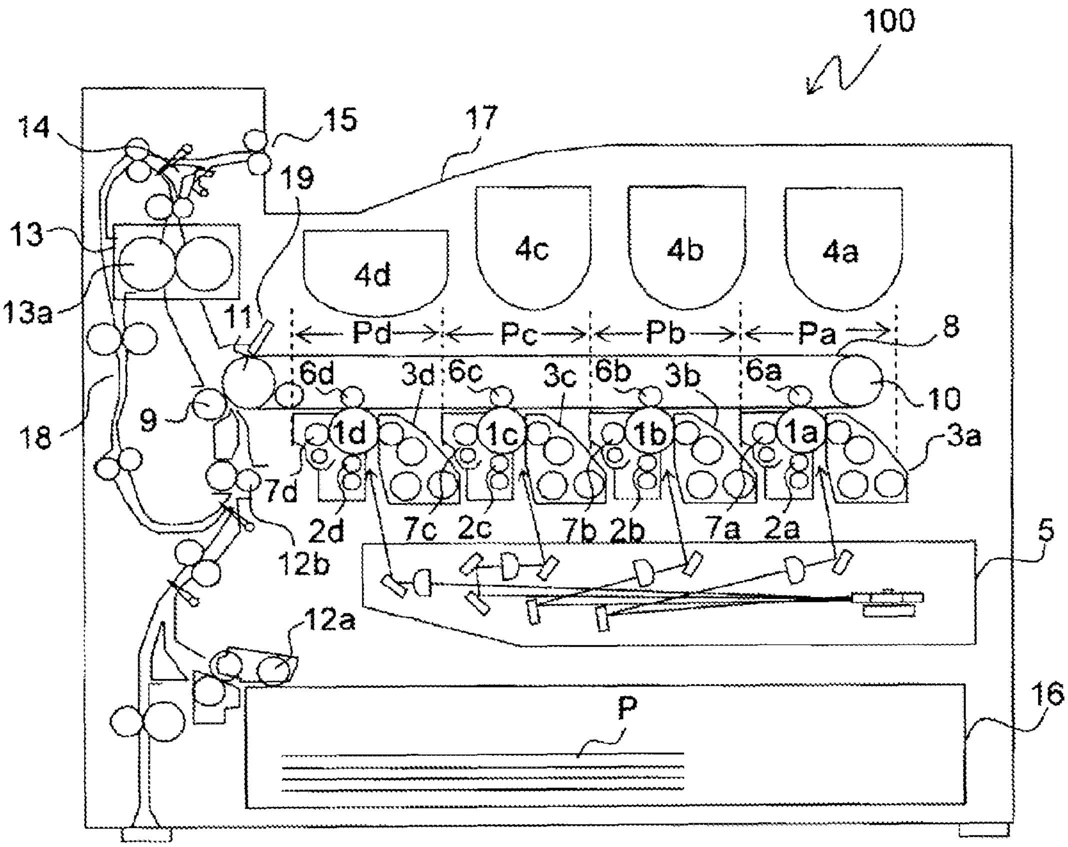

100
14
15
17
19
13
13a
4d
4c
4b
4a
11
Pd
Pc
Pb
Pa
8
6d
3d
6c
3c
6b
3b
6a
10
9
1d
1c
1b
1a
3a
18
7d
2d
7c
2c
7b
2b
7a
2a
12b
5
12a
P
16

FIG. 1

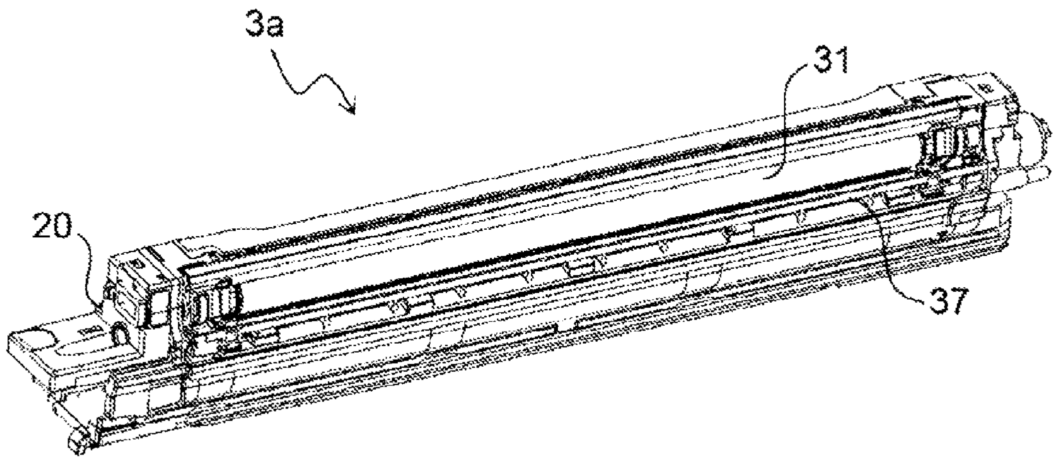


FIG. 2

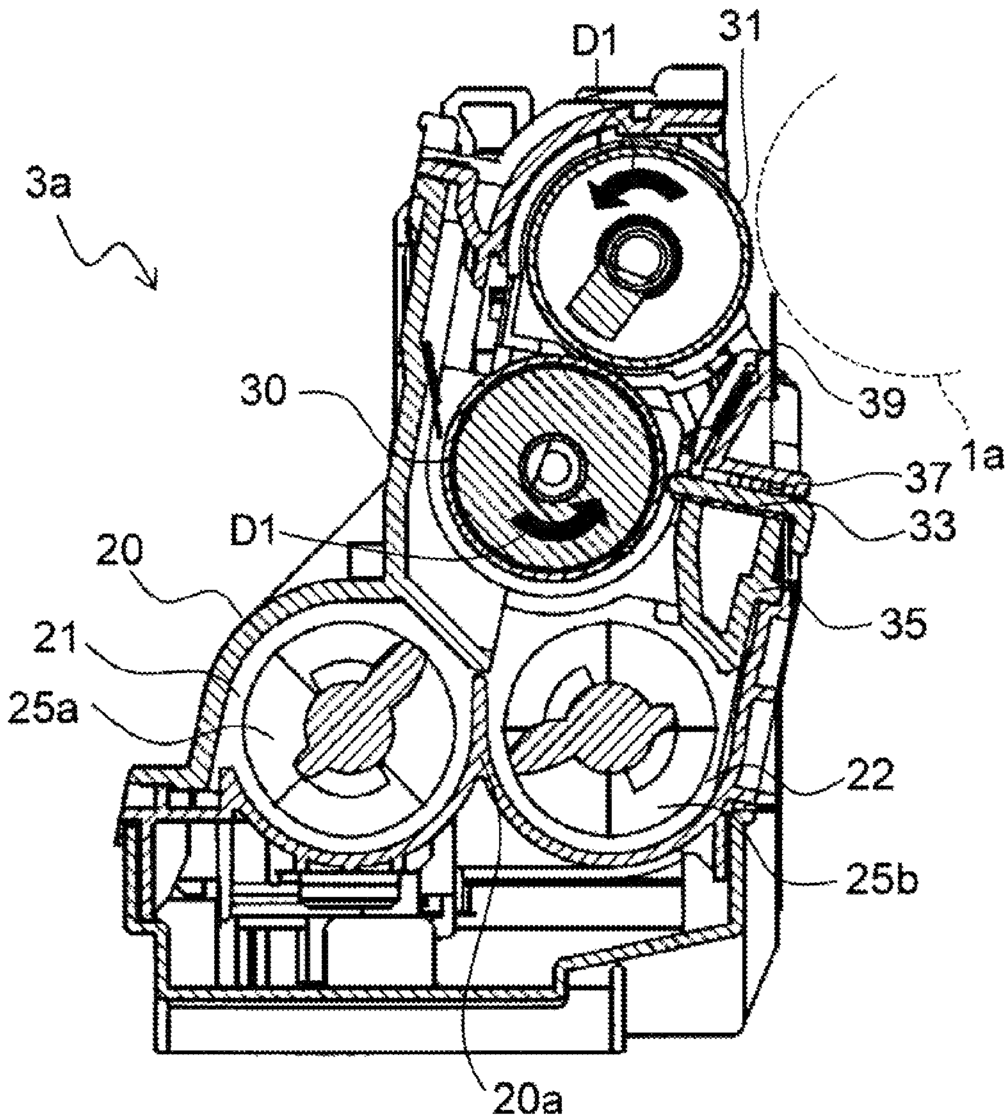


FIG. 3

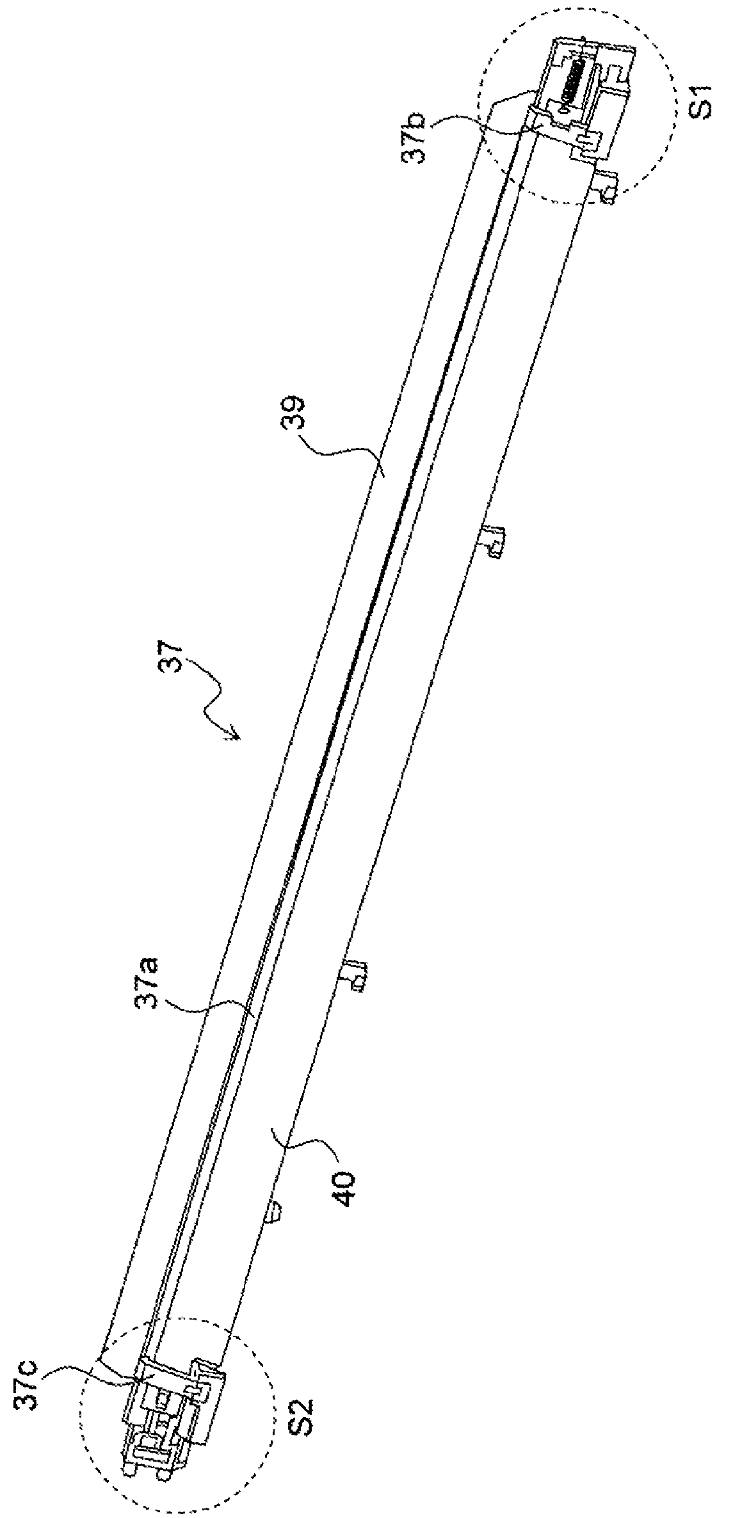


FIG. 4

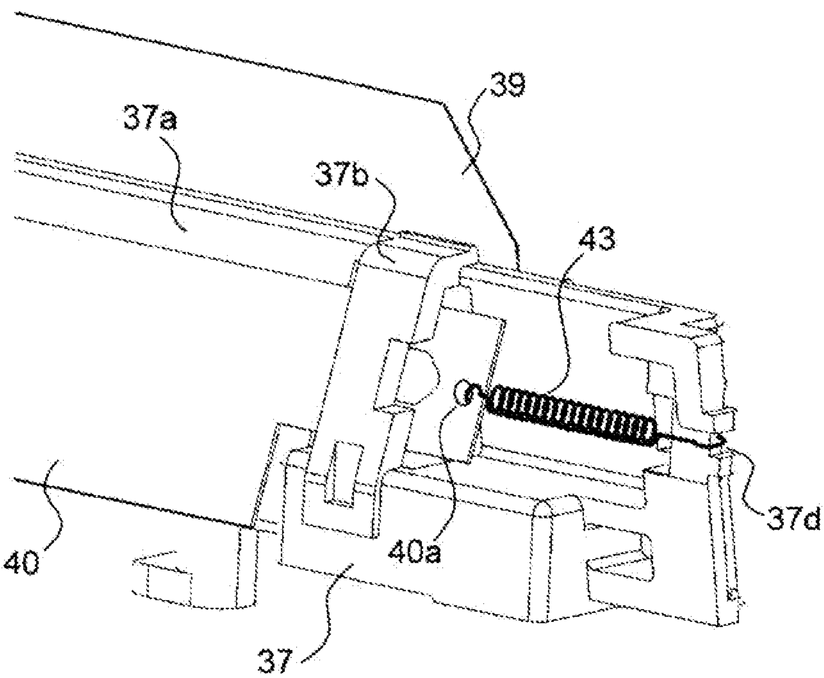


FIG. 5

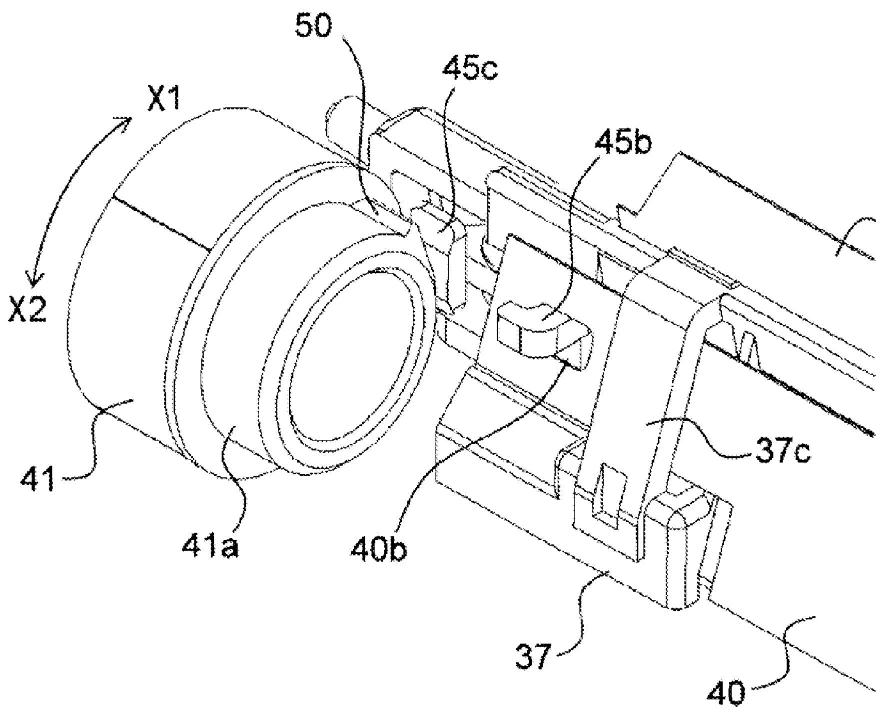


FIG. 6

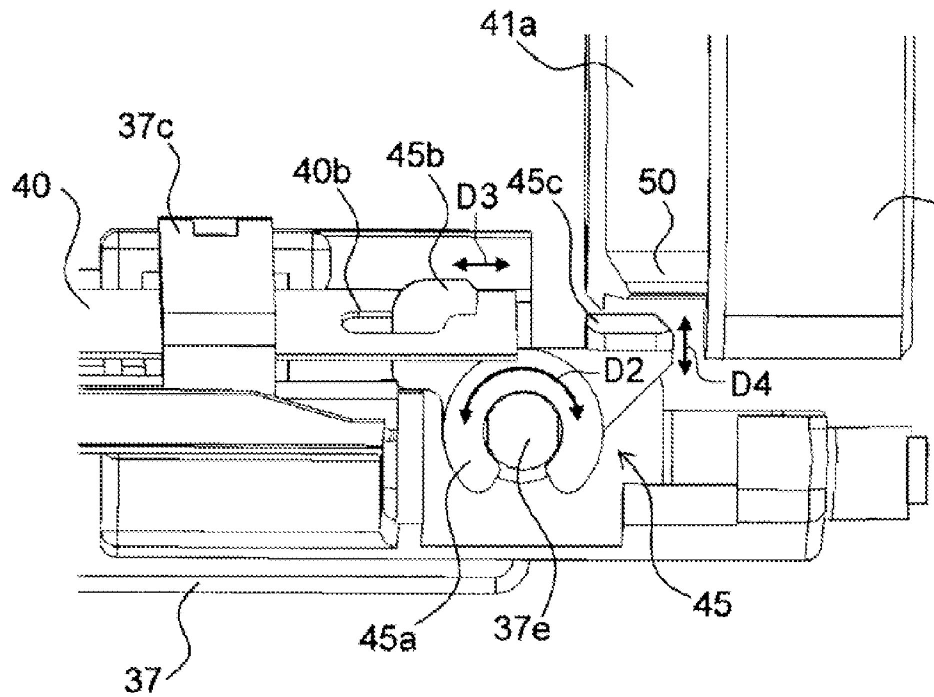


FIG. 7

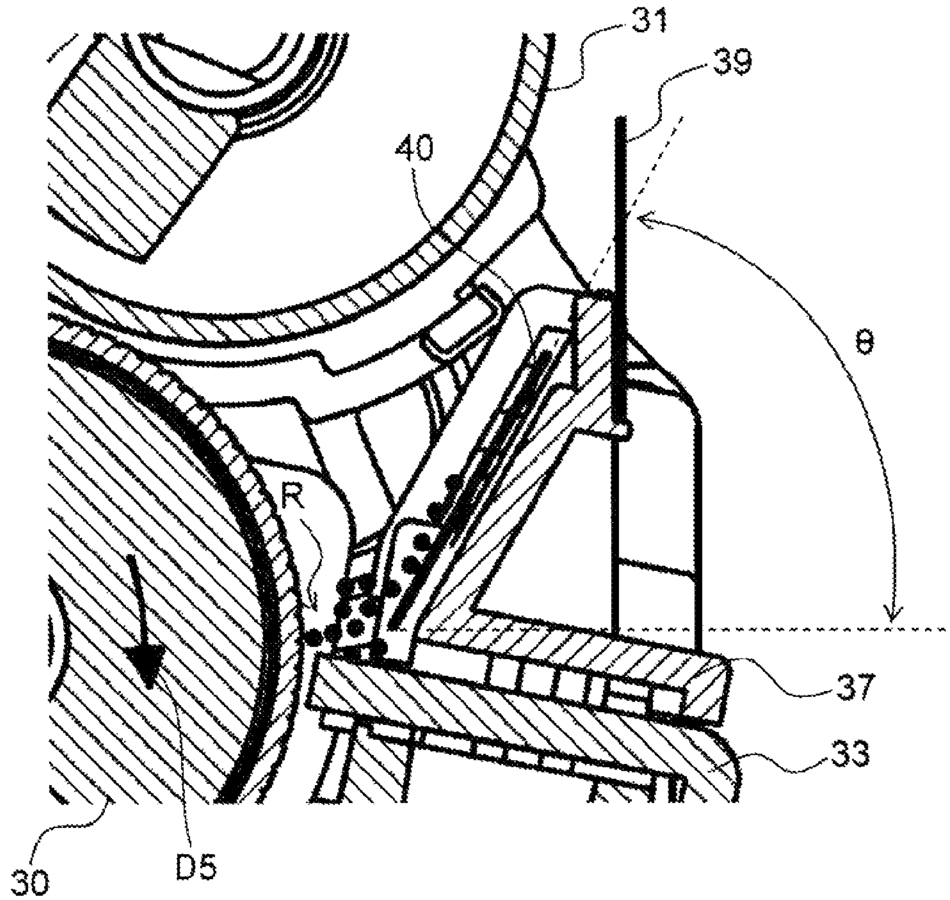


FIG. 8

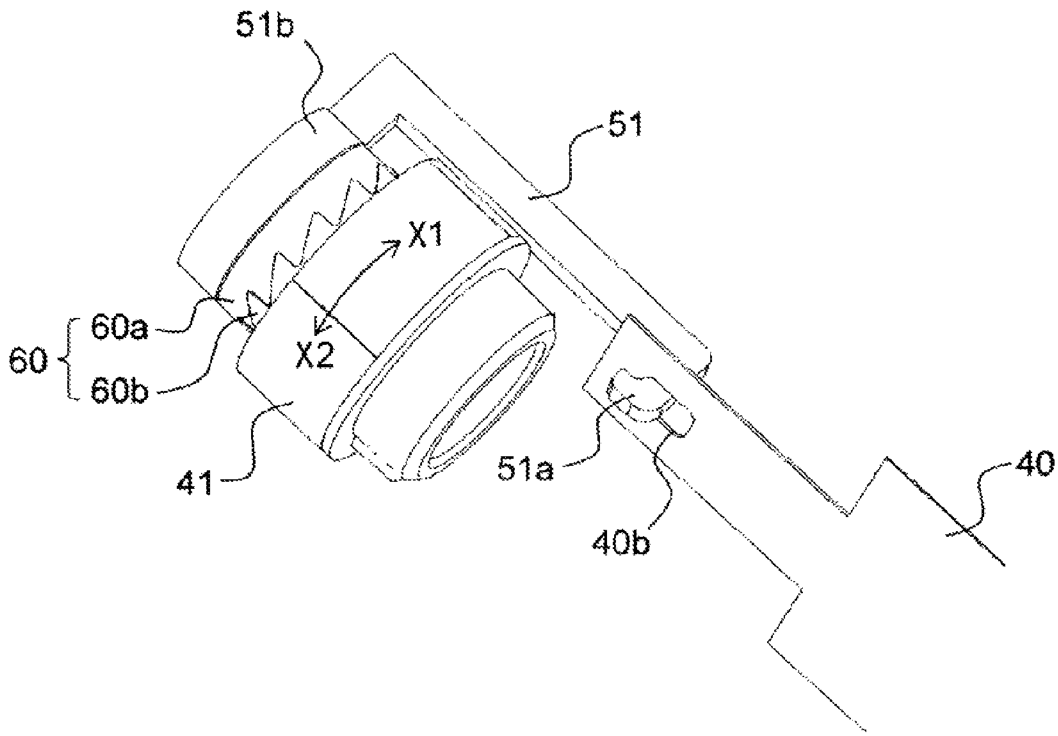


FIG. 9

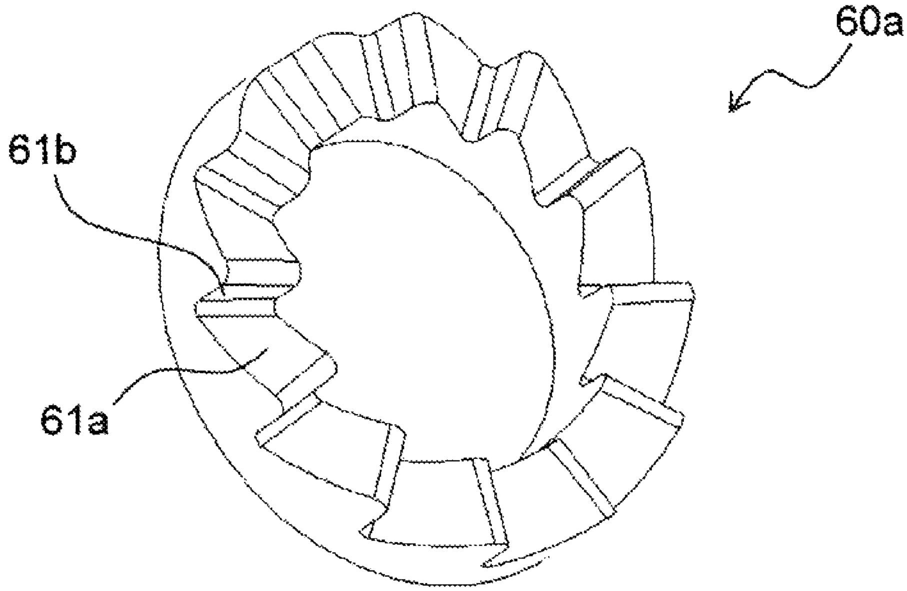


FIG. 10

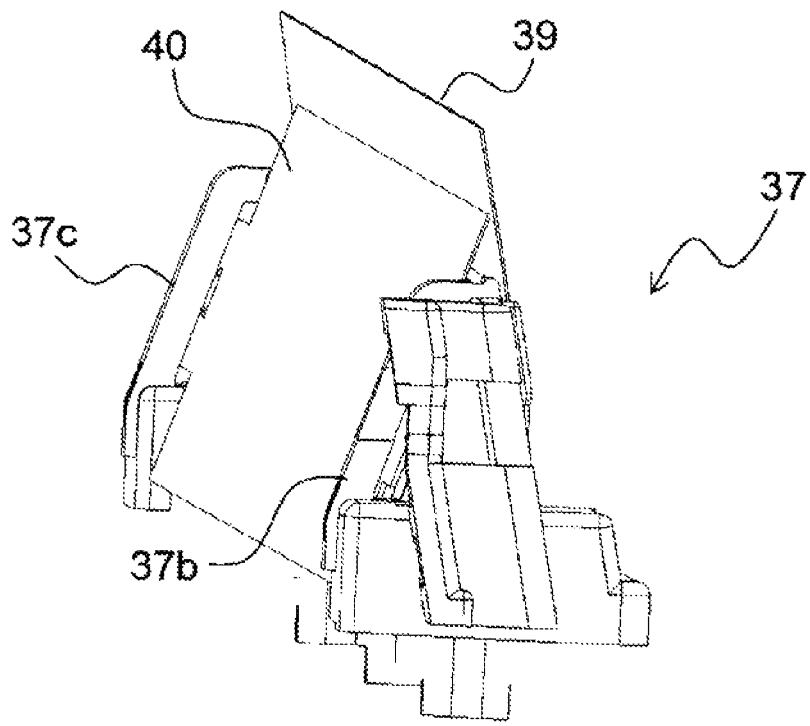


FIG. 11

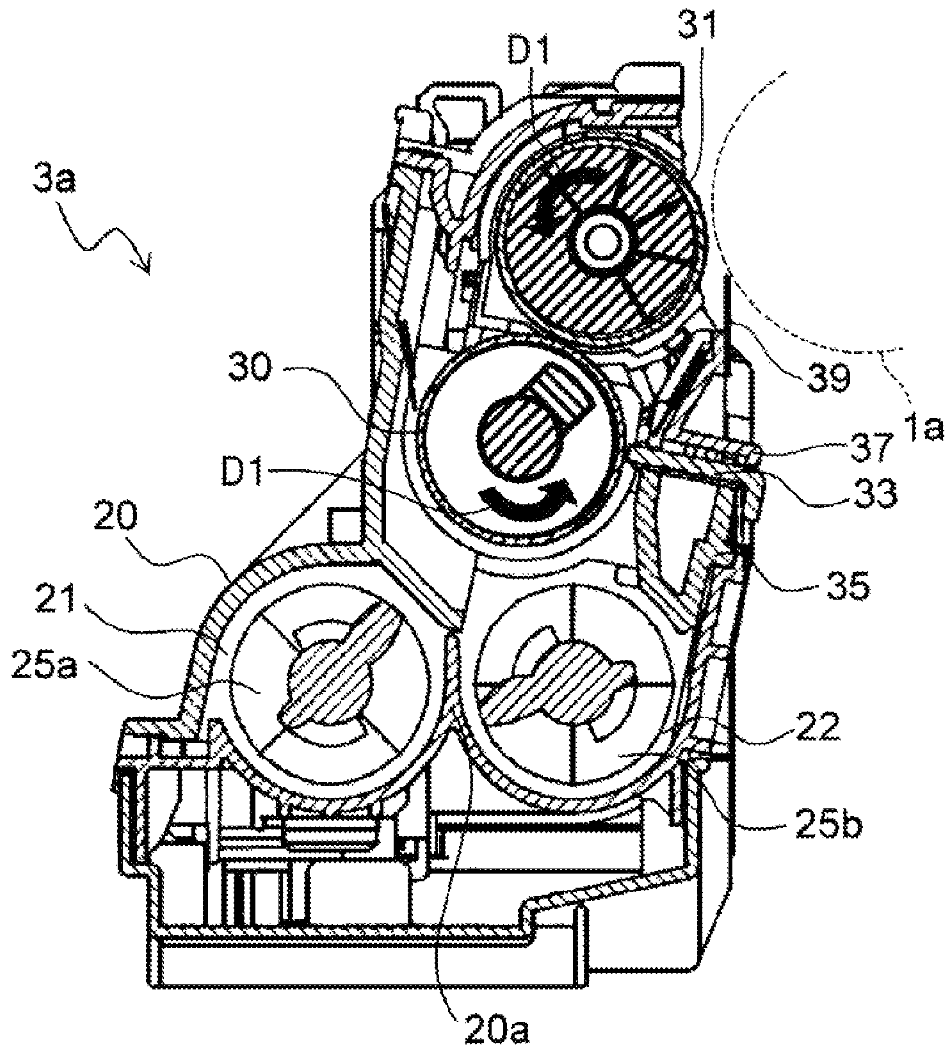


FIG. 12

DEVELOPING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SAME

INCORPORATION BY REFERENCE

The present application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2014-165708, filed Aug. 18, 2014. The contents of this application are incorporated herein by reference in their entirety.

BACKGROUND

The present disclosure relates to a developing device for supplying a developer to an image bearing member and an electrophotographic image forming apparatus including the developing device.

An electrophotographic image forming apparatus irradiates a photosensitive layer constituting a peripheral surface of a photosensitive drum (image bearing member) with light, based on image data obtained through scanning of an original document image or on image data transmitted from an external device such as a computer, to form an electrostatic latent image on the photosensitive drum. A developing device supplies toner to the photosensitive drum on which the electrostatic latent image has been formed to form a toner image. Thereafter, the toner image formed on the photosensitive drum is transferred onto paper (recording medium). The paper onto which the toner image has been transferred is subjected to fixing of the toner image thereon, and then ejected out of the apparatus.

In a known development scheme, a dry toner is used in an image forming apparatus employing an electrophotographic process. The dry toner development scheme uses a two-component developer including a magnetic carrier and a non-magnetic toner. In the two-component developer development scheme, for example, a magnetic roller (toner supplying roller) carries the developer to a development roller that is disposed out of contact with a photosensitive drum (image bearing member). During the above, only the non-magnetic toner is transferred onto the development roller with the magnetic carrier left on the magnetic roller. As a result, a thin layer of toner is formed on the development roller. The non-magnetic toner transferred to the development roller flies to the photosensitive drum due to an alternating electric field in a region where the development roller is opposite to the photosensitive drum (development region). As a result, the electrostatic latent image formed on the photosensitive drum is developed into a toner image.

In recent years, image forming apparatus configuration has become more complicated along with progress toward color printing and high-speed processing. In order to achieve high-speed processing, toner stirring members in developing devices are required to rotate at higher speed. In the above-mentioned two-component developer development scheme, in particular, a magnetic brush is formed on the magnetic roller in a region thereof opposite to the development roller, and the magnetic brush enables only the toner to be transferred onto the development roller. Toner left unused in the development is separated from the development roller. As a result, toner cloud is likely to be generated in or around a region where the development roller is opposite to the magnetic roller. Toner from the toner cloud is accumulated around a bristle cutting blade (controlling blade). The accumulated toner may aggregate and adhere to the development roller to cause an image defect leading to toner peeling.

In order to solve the problem, a developing device includes a flexible sheet member and an elliptical roller that causes swing of the sheet member in a wall portion between the controlling blade and the development region that faces toward the development roller. The sheet member constitutes a portion of an internal surface of the wall section and is swingable in a direction perpendicular to the internal surface of the wall section.

Another development device includes a shaking mechanism that accelerates toner adhering to a wall of the development device in such a direction that the toner is shaken off into a case.

In another development device, a film member is attached to an inner wall portion (sleeve cover) of a developer container disposed opposite to the development roller. While the development roller is rotating, a protrusion formed on an outer circumferential surface of a gear intermittently comes in contact with the film member to oscillate the film member. As a result, toner accumulated on the film member is shaken off.

SUMMARY

A developing device of the present disclosure includes a development roller, a toner supply roller, a controlling blade, a casing, a flexible film member, an urging member, a linkage member, and a linkage member driving mechanism. The development roller is disposed opposite to an image bearing member on which an electrostatic latent image is formed. The development roller has a first axis and supplies a developer to the image bearing member while rotating about the first axis. The toner supply roller is disposed opposite to the development roller. The toner supply roller has a second axis parallel to the first axis and supplies a toner to the development roller while rotating about the second axis. The controlling blade is disposed opposite to the toner supply roller with a predetermined gap therebetween. The casing provides accommodation for the development roller, the toner supply roller, and the controlling blade. The casing has an inner wall portion between the controlling blade and the image bearing member that faces toward the development roller. The flexible film member is disposed on the inner wall portion and elongated in a direction of the first axis. The flexible film member has ends in the direction of the first axis that are opposite to each other. The urging member is connected with one of the ends of the film member and pulls the film member. The linkage member is connected with the other of the ends of the film member in the direction of the first axis. The linkage member driving mechanism is disposed on one gear of a gear train for driving the development roller or the toner supply roller. The linkage member driving mechanism intermittently drives the linkage member in accompaniment to rotation of the gear to intermittently pull the film member in a direction parallel to the direction of the first axis and opposite to a direction in which the urging member pulls the film member, so that the film member reciprocates in directions parallel to the direction of the first axis.

An image forming apparatus of the present disclosure includes the above-described developing device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating general configuration of an image forming apparatus including developing devices of the present disclosure.

FIG. **2** is a perspective view of a developing device according to a first embodiment of the present disclosure.

FIG. **3** is a side cross-sectional view of the developing device of the first embodiment.

FIG. **4** is a perspective view of a sleeve cover that is used in the developing device of the first embodiment as viewed from the interior of a developer container.

FIG. **5** is an enlarged view of a part around a front-side end of the sleeve cover that is used in the developing device of the first embodiment.

FIG. **6** is an enlarged view of a part around a rear-side end of the sleeve cover that is used in the developing device of the first embodiment.

FIG. **7** is a top plan view of FIG. **6**.

FIG. **8** is a cross-sectional side view of a part of the developing device of the first embodiment around the sleeve cover.

FIG. **9** is an enlarged perspective view of a part around a rear-side end of a sleeve cover that is used in a developing device according to a second embodiment of the present disclosure.

FIG. **10** is a perspective view of a ratchet gear that is attached to a link arm of the developing device of the second embodiment.

FIG. **11** is a perspective view of a part of a sleeve cover that is used in a developing device according to a third embodiment of the present disclosure.

FIG. **12** is a cross-sectional side view of a developing device of the present disclosure in which the arrangement of a toner supply roller and a development roller is reversed to be opposite to that in FIG. **3**.

DETAILED DESCRIPTION

Hereinafter, embodiments of the present disclosure will be described with reference to the accompanying drawings. FIG. **1** is a schematic cross-sectional view of an image forming apparatus **100** including developing devices **3***a* to **3***d* of the present disclosure. The image forming apparatus **100** herein is a tandem color printer. The color printer **100** includes, in a main body thereof, an intermediate transfer belt **8** and four image forming sections Pa, Pb, Pc, and Pd. The intermediate transfer belt **8** is disposed opposite to the image forming sections Pa, Pb, Pc, and Pd. The intermediate transfer belt **8** is driven by a drive member (not shown) to rotate in a clockwise direction in FIG. **1**. Typically, a seamless belt formed from a dielectric resin sheet is used for the intermediate transfer belt **8**.

The image forming sections Pa, Pb, Pc, and Pd are arranged in the stated order from an upstream end (right-hand side of FIG. **1**) of a region where the intermediate transfer belt **8** is opposite to the image forming sections Pa to Pd in terms of a traveling direction of the intermediate transfer belt **8**. The image forming sections Pa to Pd are provided to form images of four different colors (cyan, magenta, yellow, and black, respectively). The image forming sections Pa to Pd sequentially form a cyan image, a magenta image, a yellow image, and a black image, respectively, through charging, light exposure, development, and transfer processes.

The image forming sections Pa to Pd include photosensitive drums **1***a*, **1***b*, **1***c*, and **1***d*, respectively, that each carry a visible image (toner image) of the corresponding color. In the present embodiment, the image formation processes are performed on the respective photosensitive drums **1***a* to **1***d* while the photosensitive drums **1***a* to **1***d* are rotating in a counterclockwise direction in FIG. **1**. In primary transfer, the toner images formed on the photosensitive drums **1***a* to **1***d* are sequentially transferred to and superimposed on the intermediate transfer belt **8** traveling in contact with the respective photosensitive drums **1***a* to **1***d*. In secondary transfer, the toner images transferred to the intermediate transfer belt **8** are transferred to paper P, which is an example of a recording medium, by the action of a secondary transfer roller **9**. The paper P having the toner images transferred thereto goes through a fixing section **13** where the toner images are fixed, and is then ejected out of the main body of the color printer **100**.

The paper P that is to receive secondary transfer of toner images is stored in a paper feed cassette **16** disposed in a lower part of the main body of the color printer **100**. The paper P stored in the paper feed cassette **16** is conveyed to a nip (secondary transfer nip) formed between the secondary transfer roller **9** and a drive roller **11** via a paper feed roller **12***a* and a registration roller pair **12***b*. A blade-like belt cleaner **19** that removes toner left on a surface of the intermediate transfer belt **8** is disposed at a location downstream of the secondary transfer nip in terms of the traveling direction of the intermediate transfer belt **8**.

Next, the image forming sections Pa to Pd will be described. Chargers **2***a*, **2***b*, **2***c*, and **2***d* that charge the photosensitive drums **1***a* to **1***d*; developing devices **3***a*, **3***b*, **3***c*, and **3***d* that form toner images on the photosensitive drums **1***a* to **1***d*; and cleaning sections **7***a*, **7***b*, **7***c*, and **7***d* that remove developer (toner) left on the photosensitive drums **1***a* to **1***d* are provided around the photosensitive drums **1***a*, **1***b*, **1***c*, and **1***d*, respectively. Furthermore, a light-exposure device **5** that exposes the respective photosensitive drums **1***a* to **1***d* with light based on image data is disposed under the photosensitive drums **1***a* to **1***d*.

First, upon input of image data from a higher-level device such as a personal computer, the chargers **2***a* to **2***d* uniformly charge surfaces of the respective photosensitive drums **1***a* to **1***d*. Next, the light-exposure device **5** irradiates (exposes) the respective photosensitive drums **1***a* to **1***d* with (to) light based on the image data to form electrostatic latent images on the photosensitive drums **1***a* to **1***d* based on the image data. Specified amounts of two-component developers containing cyan, magenta, yellow, and black toners are contained in the developing devices **3***a*, **3***b*, **3***c*, and **3***d*, respectively. The toners included in the two-component developers are supplied by the developing devices **3***a* to **3***d* onto the photosensitive drums **1***a* to **1***d* and adhere to the photosensitive drums **1***a* to **1***d* due to electrostatic force. Thus, toner images of the respective colors are formed corresponding to the electrostatic latent images formed on the photosensitive drums **1***a* to **1***d* by the light-exposure device **5**. In a situation in which the percentage of the toner included in the two-component developer contained in the developing device **3***a*, **3***b*, **3***c*, or **3***d* falls below a specified value, a corresponding toner container (replenishing member) **4***a*, **4***b*, **4***c*, or **4***d* replenishes the developing device **3***a*, **3***b*, **3***c*, or **3***d* with the toner.

After formation of the toner images of the respective colors on the photosensitive drums **1***a* to **1***d*, primary transfer is performed in which the toner images are transferred to the intermediate transfer belt **8**. More specifically, a specified transfer voltage is applied to primary transfer rollers **6***a* to **6***d*, and an electric field is formed between each of the primary transfer rollers **6***a* to **6***d* and the corresponding one of the photosensitive drums **1***a* to **1***d*. As a result, the cyan, magenta, yellow, and black toner images formed on the photosensitive drums **1***a* to **1***d* are transferred to the intermediate transfer belt **8**. The toner images of the four colors to be superimposed on one another are formed in a positional relationship predetermined for formation of a specified full-color image. After the primary transfer, the cleaning sections **7***a* to **7***d* remove toner and other foreign matter left on the surfaces of the photosensitive drums **1***a* to **1***d* in preparation for subsequent formation of new electrostatic latent images.

The intermediate transfer belt **8** is wound around a driven roller **10** upstream and the drive roller **11** downstream in terms of the traveling direction in a region opposite to the photosensitive drums **1***a* to **1***d*.

The drive roller **11** is driven to rotate by a drive motor (not shown). The paper P is conveyed from the registration roller pair **12***b* to the secondary transfer nip at a specific timing while the intermediate transfer belt **8** is rotating in the clockwise direction in FIG. **1** in accompaniment to the rotation of the drive roller **11**. Then, the secondary transfer is performed in which the toner images transferred to the intermediate transfer belt **8** are transferred to the paper P. The paper P having the toner images transferred thereto is conveyed to the fixing section **13**.

Heat and pressure are applied by a fixing roller pair **13***a* to the paper P conveyed to the fixing section **13** so that the toner images are fixed on a surface of the paper P. Thus, a specified full-color image is formed. The conveyance direction of the paper P having the full-color image formed thereon is switched by a diverging section **14** diverging in a plurality of directions. For printing in which an image is formed only on one side of a sheet of paper P, the paper P that has passed through the fixing section **13** is directly ejected to an exit tray **17** by ejection rollers **15**.

For printing in which images are formed on both sides of a sheet of paper P, the paper P that has passed through the fixing section **13** is initially conveyed toward the ejection rollers **15**. Once a trailing end of the paper P passes the diverging section **14**, the rotation of the ejection rollers **15** is reversed, and at the same time, the diverging section **14** switches the conveyance direction. Consequently, the paper P is guided into a reverse conveyance path **18** with the trailing end thereof in the lead and conveyed back to the secondary transfer nip with the orientation of a printed side thereof reversed. Then, secondary transfer is performed in which next toner images formed on the intermediate transfer belt **8** are transferred to an unprinted side of the paper P by the secondary transfer roller **9**. The paper P having the toner images transferred thereto is conveyed to the fixing section **13** where the toner images are fixed, and then ejected onto the exit tray **17**.

FIG. **2** is an external perspective view of the developing device **3***a* according to a first embodiment of the present disclosure. FIG. **3** is a schematic cross-sectional side view of the developing device **3***a* of the first embodiment. The photosensitive drum **1***a* is depicted by a dashed line in FIG. **3** in order to assist with understanding. A distance between the photosensitive drum **1***a* and a development roller **31** illustrated in FIG. **3** is not true to scale. In addition, FIG. **3** shows the developing device **3***a* as viewed from a back side of FIG. **1**, and thus the arrangement of the elements in the developing device **3***a* shown in FIG. **3** has right and left reversed relative to those of the arrangement shown in FIG. **1**. Furthermore, in the following description, the developing device **3***a* disposed in the image forming section Pa in FIG. **1** is used as an example. Since basic configuration of the developing devices **3***b* to **3***d* disposed in the image forming sections Pb to Pd is the same as that of the developing device **3***a*, description thereof will be omitted. In the following description, a fore side of the main body of the color printer **100** is referred to as a front side, and a back side of the main body of the color printer **100** is referred to as a rear side. For example, in FIG. **2**, a left end of the developing device **3***a* is at the front side, and a right end thereof is at the rear side.

As illustrated in FIGS. **2** and **3**, the developing device **3***a* includes a developer container (casing) **20** in which a two-component developer (hereinafter, may be referred to simply as a developer) is contained. The two-component developer includes a toner and a carrier. The developer container **20** is divided by a partition wall **20***a* into a stirring conveyance chamber **21** and a supplying conveyance chamber **22**. A stirring conveyance screw **25***a* is rotatably disposed in the stirring conveyance chamber **21**. A supplying conveyance screw **25***b* is rotatably disposed in the supplying conveyance chamber **22**. The stirring conveyance screw **25***a* and the supplying conveyance screw **25***b* mix and stir the toner (positively chargeable toner) and the carrier supplied from the toner container **4***a* (see FIG. **1**) to the developer container **20**. As a result, the toner is charged.

The developer is conveyed in an axial direction of the stirring conveyance screw **25***a* and the supplying conveyance screw **25***b* (in a direction perpendicular to the page of FIG. **3**) while being stirred by the stirring conveyance screw **25***a* and the supplying conveyance screw **25***b*. Thus, the developer is circulated between the stirring conveyance chamber **21** and the supplying conveyance chamber **22** through developer carrying paths, not shown, formed at opposite ends of the partition wall **20***a*. That is, the stirring conveyance chamber **21**, the supplying conveyance chamber **22**, and the developer carrying paths form a circulation path of the developer in the developer container **20**.

The developer container **20** extends obliquely toward the upper right in FIG. **3**. A toner supply roller **30** is disposed above the supplying conveyance screw **25***b* in the developer container **20**. The development roller **31** is disposed at the upper right of the toner supply roller **30**. The development roller **31** is opposite to the toner supply roller **30** with a predetermined gap therebetween. The development roller **31** is opposite to the photosensitive drum **1***a* with an opening (right-hand side of FIG. **3**) of the developer container **20** therebetween. The development roller **31** and the photosensitive drum **1***a* have a predetermined gap therebetween.

The toner supply roller **30** and the development roller **31** each have a rotational axis. The rotational axis of the toner supply roller **30** is parallel to the rotational axis of the development roller **31**. The toner supply roller **30** and the development roller **31** independently rotate about their own rotational axes in a direction indicated by arrow D**1** (in a counterclockwise direction in FIG. **3**). The rotational axis of the development roller **31** is an example of the first axis, and the rotational axis of the toner supply roller **30** is an example of the second axis.

The stirring conveyance chamber **21** is provided with a toner concentration sensor, not shown, facing toward the stirring conveyance screw **25***a*. Toner is supplied from the toner container **4***a* to the stirring conveyance chamber **21** through a toner supply opening, not shown, based on a result of detection that is performed by the toner concentration sensor. For example, a magnetic permeability sensor that detects a magnetic permeability of the two-component developer including the toner and the carrier contained in the developer container **20** is used for the toner concentration sensor.

The toner supply roller **30** is a magnetic roller. More specifically, the toner supply roller **30** includes a non-magnetic rotational sleeve that rotates in the direction indicated by arrow D**1** and a stationary magnetic body that has a plurality of magnetic poles and is included in the rotational sleeve. The toner supply roller **30** carries the developer thereon.

The development roller **31** is a magnetic roller. More specifically, the development roller **31** includes a cylindrical development sleeve that rotates in the direction indicated by arrow D**1** and development roller magnetic poles fixed in the development sleeve. The magnetic poles in the development roller are disposed opposite to the plurality of magnetic poles of the stationary magnetic body. Each of the magnetic poles in the development roller has a polarity opposite to a polarity of the corresponding magnetic pole (main pole) of the stationary magnetic body. The development roller **31** carries the developer thereon.

Furthermore, a bristle cutting blade (controlling blade) **33** is provided in the developer container **20**, extending in an axial direction of the toner supply roller **30** (in the direction perpendicular to the page of FIG. **3**). More specifically, the bristle cutting blade **33** is fastened to a blade supporting frame strut **35** attached to the developer container **20** with a fastening screw (not shown). The bristle cutting blade **33** is located upstream of a region where the toner supply roller **30** is opposite to the development roller **31** in terms of a rotation direction of the toner supply roller **30** (in the counterclockwise direction in FIG. **3**). There is a small gap between a tip of the bristle cutting blade **33** in terms of a direction perpendicular to the axial direction of the toner supply roller **30** and a surface of the toner supply roller **30**.

A direct-current voltage (hereinafter, referred to as Vslv (DC)) and an alternating-current voltage (hereinafter, referred to as Vslv (AC)) are applied to the development roller **31**. A direct-current voltage (hereinafter, referred to as Vmag (DC)) and an alternating-current voltage (hereinafter, referred to as Vmag (AC)) are applied to the toner supply roller **30**. The direct-current voltages and the alternating-current voltages are applied to the development roller **31** and the toner supply roller **30** from a development bias power source (not shown) via a bias control circuit (not shown).

As described above, the developer is circulated between the stirring conveyance chamber **21** and the supplying conveyance chamber **22** in the developer container **20** while being stirred by the stirring conveyance screw **25***a* and the supplying conveyance screw **25***b*, and thus the toner included in the developer is charged. The developer in the supplying conveyance chamber **22** is conveyed to the toner supply roller **30** by the supplying conveyance screw **25***b*. As a result, a magnetic brush (not shown) is formed on the toner supply roller **30**. The thickness of a layer of the magnetic brush formed on the toner supply roller **30** is controlled by the bristle cutting blade **33**. Thereafter, the magnetic brush is conveyed to the region where the toner supply roller **30** is opposite to the development roller **31** as the toner supply roller **30** rotates. Then, Vmag (DC) is applied to the toner supply roller **30**, and Vslv (DC) is applied to the development roller **31** to generate a potential difference ΔV and a magnetic field between the toner supply roller **30** and the development roller **31**. As a result, a thin layer of toner is formed on the development roller **31**.

The thickness of the toner layer on the development roller **31** varies according to factors such as the resistance of the developer and a rotational speed difference between the toner supply roller **30** and the development roller **31**. The thickness can also be adjusted by controlling ΔV. The thickness of the toner layer on the development roller **31** is increased by increasing ΔV and decreased by decreasing ΔV. In general, an appropriate range of ΔV in the development is approximately 100 V to 350 V.

The toner thin layer formed on the development roller **31** is conveyed to a region where the development roller **31** is opposite to the photosensitive drum **1***a* with the rotation of the development roller **31**. As described above, Vslv (DC) and Vslv (AC) are applied to the development roller **31**. A potential difference between the development roller **31** and the photosensitive drum **1***a* causes the toner to fly from the development roller **31** to the photosensitive drum **1***a*, and the electrostatic latent image on the photosensitive drum **1***a* is developed with the toner.

Toner left unused in the development is conveyed to the region where the development roller **31** is opposite to the toner supply roller **30** with the rotation of the development roller **31**, and then collected by the magnetic brush formed on the toner supply roller **30**. The magnetic brush is separated from the toner supply roller **30** at a region of the stationary magnetic body where adjacent homopolar magnetic poles are included, and then falls off into the supplying conveyance chamber **22**.

Thereafter, a specified amount of toner is supplied to the developer container **20** from the toner supply opening (not shown) based on a result of detection by the toner concentration sensor (not shown). As a result, the two-component developer has the toner concentration returned to an appropriate concentration and the toner charged uniformly while being circulated between the supplying conveyance chamber **22** and the stirring conveyance chamber **21**. This developer is supplied onto the toner supply roller **30** by the supplying conveyance screw **25***b* to form a magnetic brush, and then conveyed to the bristle cutting blade **33**.

A sleeve cover **37** is provided at a right-side wall of the developer container **20** in FIG. **3** in the vicinity of the development roller **31**. The sleeve cover **37** has a substantially V-shaped cross-section protruding toward the interior of the developer container **20**. More specifically, the sleeve cover **37** illustrated in FIG. **3** is elongated in an axial direction of the development roller **31** (in the direction perpendicular to the page of FIG. **3**). The sleeve cover **37** has an upper surface **37***a* (see FIG. **4**) constituting an inner wall portion of the developer container **20** and facing toward the development roller **31**.

An upper end of the sleeve cover **37** is provided with a sheet-like seal member **39**. The seal member **39** extends in the axial direction of the development roller **31**. That is, the seal member **39** has a longitudinal direction in the axial direction of the development roller **31** and a lateral direction in a direction perpendicular to the axial direction. An edge of the seal member **39** in the lateral direction is in contact with the surface of the photosensitive drum **1***a* (see FIG. **1**). The seal member **39** has a function of blocking leaking of the toner out of the developer container **20**.

FIG. **4** is a perspective view of the sleeve cover **37** as viewed from the interior (left-hand side of FIG. **3**) of the developer container **20**. The upper surface **37***a* of the sleeve cover **37** supports a film member **40** elongated in the axial direction of the development roller **31**. As illustrated in FIG. **4**, the film member **40** is disposed over substantially the entirety of the upper surface **37***a* of the sleeve cover **37** (over an area opposite to the entirety of the development roller **31** in terms of the axial direction). That is, the film member **40** has a longitudinal direction in the axial direction of the development roller **31**. In the present embodiment, the film member **40** is formed from a flexible resin material such as a PET film. Preferably, the film member **40** is made more resistant to toner adhesion than the sleeve cover **37** by forming the film member **40** using a fluororesin film or coating the film member **40** with fluororesin. The film member **40** needs to have a certain degree of resilience (elasticity) in order to be capable of the later-described reciprocating movement under tension.

Ends of the upper surface **37***a* of the sleeve cover **37** in terms of the axial direction of the development roller **31**, that is, a front-side end (right-hand end in FIG. **4**) and a rear-side end (left-hand end in FIG. **4**) of the upper surface **37***a* include guide portions **37***b* and **37***c*, respectively. The guide portions

37*b* and 37*c* receive insertion of ends of the film member 40 in terms of the longitudinal direction thereof (rear-side end and front-side end), respectively. The rear-side end of the film member 40 extends toward the rear side farther from the guide portion 37*c*. More specifically, an edge of the rear-side end of the film member 40 is in the vicinity of an idler gear 41 (see FIG. 6). The idler gear 41 is disposed at the rear side of the developing device 3*a* and transmits driving force to a drive input gear of the development roller 31.

FIG. 5 is an enlarged view of a part around a front-side end of the sleeve cover 37 (within a dashed circle S1 in FIG. 4). FIG. 6 is an enlarged view of a part around the rear-side end of the film member 40 (within a dashed circle S2 in FIG. 4). FIG. 7 is a top plan view of FIG. 6. FIGS. 5 and 6 illustrate the sleeve cover 37 and the film member 40 as viewed from the interior (left-hand side of FIG. 3) of the developing device 3*a*.

At the front-side end of the sleeve cover 37, as illustrated in FIG. 5, one end of the film member 40 in terms of the longitudinal direction has an engagement hole 40*a*. One end of a coil spring 43 engages with the engagement hole 40*a*. The other end of the coil spring 43 engages with an engagement portion 37*d* of the sleeve cover 37. Thus, the coil spring 43 urges the one end (front-side end) of the film member 40 toward the front side. At the rear-side end of the sleeve cover 37, as illustrated in FIGS. 6 and 7, the other end of the film member 40 in terms of the longitudinal direction has a rectangular engagement hole 40*b*. A hook portion 45*b* of a linkage member 45 engages with the engagement hole 40*b*. Thus, the movement of the other end of the film member 40 is restricted by the hook portion 45*b*. Accordingly, predetermined tensile force (tension) is given to the film member 40 in the longitudinal direction of the film member 40 (in the axial direction of the development roller 31.

As illustrated in FIG. 7, the linkage member 45 has an arc-shaped support portion 45*a*, the hook portion 45*b* extending from the support portion 45*a*, and a trigger 45*c* extending from the support portion 45*a*. The support portion 45*a* is turnably received over a boss portion 37*e* formed in the sleeve cover 37. That is, the linkage member 45 is supported such as to be swingable about the boss portion 37*e* relative to the sleeve cover 37. In the example illustrated in FIG. 7, the linkage member 45 is swingable in directions indicated by arrow D2. In accompaniment to the linkage member 45 swinging in the directions indicated by arrow D2, the hook portion 45*b* moves in directions indicated by arrow D3, and the trigger 45*c* moves in directions indicated by arrow D4.

As illustrated in FIG. 6, the trigger 45*c* faces toward an outer circumferential surface of a cylindrical portion 41*a*. The cylindrical portion 41*a* is integrated with the idler gear 41 on a side facing the film member 40. The hook portion 45*b* engages with the engagement hole 40*b* of the film member 40. Thus, the urging force of the coil spring 43 acts on the linkage member 45 via the film member 40, urging the hook portion 45*b* toward the one end (front-side end) of the film member 40.

The outer circumferential surface of the cylindrical portion 41*a* has a peak-shaped protrusion 50. The protrusion 50 comes in contact with the trigger 45*c* as the cylindrical portion 41*a* rotates in accompaniment to the rotation of the idler gear 41.

The idler gear 41 rotates in a direction indicated by arrow X1 shown in FIG. 6 (an example of the first direction) in accompaniment to the rotation of the toner supply roller 30 and the development roller 31 during image formation. At the same time, the cylindrical portion 41*a* also rotates in the direction indicated by arrow X1. The protrusion 50 formed on the cylindrical portion 41*a* intermittently comes in contact with the trigger 45*c* while the cylindrical portion 41*a* is rotating.

The intermittent contact between the protrusion 50 and the trigger 45*c* causes the linkage member 45 to swing about the boss portion 37*e* as illustrated in FIG. 7. Thus, the hook portion 45*b* intermittently pulls the other end (rear-side end) of the film member 40 against the urging force of the coil spring 43. As a result, the film member 40 intermittently moves toward the rear side. Accordingly, the film member 40 reciprocates (slides) with a small amplitude and at a high frequency in the longitudinal direction thereof while causing expansion and contraction of the coil spring 43 connected with the one end (front-side end).

The frequency of the reciprocating movement of the film member 40 varies according to the number of protrusions 50. The amplitude of the reciprocating movement of the film member 40 varies according to the protrusion distance of each protrusion 50. That is, the amplitude, the frequency, and so on of the reciprocating movement of the film member 40 can be varied as appropriate by varying the protrusion distance of the protrusion 50 or the number of protrusions 50.

FIG. 8 is a cross-sectional side view of a part of the developing device 3*a* of the present embodiment around the sleeve cover 37. As illustrated in FIG. 8, the toner accumulated on the film member 40 is shaken off the film member 40 due to the above-described reciprocating movement of the film member 40. According to the present embodiment, the film member 40 reciprocates using the rotation of the idler gear 41 that is used for rotationally driving the toner supply roller 30 and the development roller 31. That is, the film member 40 reciprocates in accompaniment to the rotation of the toner supply roller 30 and the development roller 31. Therefore, even if the toner supply roller 30 and the development roller 31 in the developing device 3*a* rotate at a high speed and a large amount of toner cloud is generated in the developer container 20, accumulation of toner on the upper surface 37*a* of the sleeve cover 37 can be restricted. Toner accumulated on the upper surface 37*a* of the sleeve cover 37 may go through aggregation (blocking) and then adhere to the toner supply roller 30 or the development roller 31. If aggregated toner adheres to the toner supply roller 30 or the development roller 31, an image defect leading to toner peeling may occur. However, according to the present embodiment, toner slides along and falls off the film member 40 into a region R between the sleeve cover 37 and the toner supply roller 30 due to the reciprocating movement of the film member 40. As a result, the possibility of the image defect can be reduced effectively.

The entirety of the film member 40 reciprocates in the longitudinal direction of the film member 40. Accordingly, the effect of shaking off toner is consistent throughout the longitudinal direction of the film member 40 and it is possible to shake off toner accumulated on the film member 40 regardless of location on the film member 40. In order that toner accumulated on the film member 40 falls off smoothly, an angle of inclination θ of the film member 40 relative to the horizontal plane is preferably no less than 55°.

According to the present embodiment, the reciprocating movement of the film member 40 restricts accumulation of toner on the upper surface 37*a* of the sleeve cover 37. This configuration eliminates the need for a separate toner removing member such as a brush member that removes toner on the sleeve cover 37. As a result, the configuration of the color printer 100 is compact and space-saving. With the toner removing member, a foreign substance resulting from the toner removing member may be circulated together with the developer in the developer container 20. However, the present embodiment eliminates the need for the separate toner removing member. It is therefore possible to prevent a foreign substance resulting from the toner removing member from getting stuck between the bristle cutting blade **33** and the toner supply roller **30**. Accordingly, a defective image such as an image with a void defect can be effectively avoided.

Furthermore, the film member **40** reciprocates using the rotation of the idler gear **41**. This configuration eliminates the need for a dedicated motor, actuator, and so on for oscillating the film member **40**. As a result, the internal configuration of the developing device **3***a* can be simplified.

During a time when image formation is not performed, the toner supply roller **30** is preferably driven to rotate in a reverse direction (in a clockwise direction in FIG. **8**) that is opposite to the direction of the rotation thereof during image formation in order to return toner collected in the region R to the supplying conveyance chamber **22**. That is, once in the region R, toner is temporarily accumulated around an edge of the bristle cutting blade **33** in terms of the lateral direction thereof and then collected by the magnetic brush formed on the surface of the toner supply roller **30** because of the rotation of the toner supply roller **30** in the reverse direction. The toner collected by the magnetic brush passes through the gap between the toner supply roller **30** and the bristle cutting blade **33** as the toner supply roller **30** rotates, and is separated from the toner supply roller **30** by the action of the region of the stationary magnetic body where adjacent homopolar magnetic poles are included. Consequently, the toner is forced back into the supplying conveyance chamber **22** (see FIG. **3**).

Timing for driving the toner supply roller **30** to rotate in the reverse direction can be determined as appropriate according to the degree of the toner accumulation on the film member **40**. For example, the timing may be when the color printer **100** is activated (turned on), when the color printer **100** is released from a power-saving (sleep) mode, or when printing has been performed on a predetermined number of sheets of paper.

When the toner supply roller **30** is driven to rotate in the reverse direction that is opposite to the rotation direction during image formation, the idler gear **41** also rotates in a reverse direction (an example of the second direction) that is opposite to the rotation direction thereof during image formation. In the example shown in FIG. **6**, the idler gear **41** rotates in a direction indicated by arrow X2. Even in such a situation, the protrusion **50** formed on the cylindrical portion **41***a* intermittently comes in contact with the trigger **45***c* of the linkage member **45**. Thus, the linkage member **45** can swing as in image formation, causing the reciprocating movement of the film member **40**.

Although the present embodiment is described using a configuration in which the cylindrical portion **41***a* of the idler gear **41** has one protrusion **50** as an example, the number of protrusions **50** is not limited to one. The cylindrical portion **41***a* may have two or more protrusions **50**.

Next, a second embodiment will be described focusing on differences thereof from the first embodiment with reference to FIGS. **9** and **10**. The second embodiment has a different configuration from the first embodiment for the reciprocating movement of the film member **40**.

FIG. **9** is an enlarged view of a part around the rear-side end of the sleeve cover **37** that is used in the developing device **3***a* according to the second embodiment of the present disclosure. The configuration around the front-side end of the sleeve cover **37** is the same as that of the first embodiment illustrated in FIG. **5**. As illustrated in FIG. **9**, a hook portion **51** a of a link arm **51** engages with the engagement hole **40***b* of the film member **40** at the rear-side end of the sleeve cover **37**.

As in the first embodiment, one end (front-side end) of the film member **40** is urged by the coil spring **43** (see FIG. **5**) toward the front side. The movement of the other end (rear-side end) of the film member **40** is restricted by engagement between the engagement hole **40***b* and the link arm **51**. Accordingly, predetermined tensile force (tension) is given to the film member **40** in the longitudinal direction of the film member **40**.

The link arm **51** includes the hook portion **51***a* at one end and a disc-shaped gear supporting portion **51***b* at the other end. The hook portion **51***a* engages with the engagement hole **40***b* of the film member **40**. The gear supporting portion **51***b* supports a ratchet gear **60***a* such that the gear is rotatable only in one direction (in a direction indicated by arrow X1 in FIG. **9**). The gear supporting portion **51***b* faces a side surface of the idler gear **41** with the ratchet gear **60***a* and a ratchet gear **60***b* in meshing engagement with the ratchet gear **60***a* therebetween. As described above, the urging force of the coil spring **43** acts on the film member **40**. The urging force of the coil spring **43** therefore acts on the gear supporting portion **51***b* via the film member **40**. As a result, the gear supporting portion **51***b* is urged in a direction toward the idler gear **41**.

FIG. **10** is a perspective view of the ratchet gear **60***a*. The ratchet gear **60***a* includes less inclined first gear tooth flanks **61***a* and more inclined second gear tooth flanks **61***b* that are alternately arranged.

The ratchet gear **60***b* is fixed to the side surface of the idler gear **41** facing the gear supporting portion **51***b*. The ratchet gear **60***b* has the same configuration as the ratchet gear **60***a* illustrated in FIG. **10** except that the orientation of the first gear tooth flanks **61***a* and the orientation of the second gear tooth flanks **61***b* therein are different from those in the ratchet gear **60***a*. The profile (protrusion distance) or the number of the teeth of the ratchet gears **60***a* and **60***b* may be changed. The ratchet gears **60***a* and **60***b* form a ratchet mechanism **60** capable of transmitting driving force in only one direction (in a direction indicated by arrow X1 in FIG. **9**).

The idler gear **41** rotates in the direction indicated by arrow X1 in FIG. **9** as the toner supply roller **30** and the development roller **31** are driven to rotate during the image formation. In the meantime, the ratchet gear **60***a* and the ratchet gear **60***b* integrally rotate in the direction indicated by arrow X1 with the more inclined second gear tooth flanks **61***b* of the respective ratchet gears in meshing engagement. Accordingly, the link arm **51** remains still without sliding.

The idler gear **41** rotates in a direction indicated by arrow X2 in FIG. **9** as the toner supply roller **30** and the development roller **31** are driven to rotate in the reverse direction during a time when image formation is not performed. In the meantime, the ratchet gear **60***a* and the ratchet gear **60***b* attempt to rotate in the direction indicated by arrow X2 with the less inclined first gear tooth flanks **61***a* of the respective ratchet gears in meshing engagement. However, as described above, the rotation of the ratchet gear **60***a* in the direction indicated by arrow X2 is restricted. The ratchet gear **60***a* therefore slides relative to the ratchet gear **60***b* with the first gear tooth flanks **61***a* of the ratchet gear **60***a* mounting the first gear tooth flanks **61***a* of the ratchet gear **60***b* against the urging force of the coil spring **43**. The first gear tooth flanks **61***a* of the ratchet gear **60***a* then fall out of the first gear tooth flanks **61***a* of the ratchet gear **60***b*. The ratchet gear **60***a* repeats the above-described movement as long as the idler gear **41** is rotating. As a result, the gear supporting portion **51***b* swings in directions toward and away from the idler gear **41**. Accordingly, the link arm **51** reciprocates in a longitudinal direction of the sleeve cover **37** with a small amplitude and at a high frequency.

According to this configuration, the other end (rear-side end) of the film member **40** is intermittently pulled by the hook portion **51***a*, and thus the film member **40** reciprocates in the longitudinal direction thereof while causing expansion and contraction of the coil spring **43** connected with the one end (front-side end) of the film member **40**.

As illustrated in FIG. **8**, toner accumulated on the film member **40** is shaken off the film member **40** due to the above-described reciprocating movement of the film member **40**. Therefore, even if the toner supply roller **30** and the development roller **31** in the developing device **3***a* rotate at a high speed and a large amount of toner cloud is generated in the developer container **20**, accumulation of toner on the upper surface **37***a* of the sleeve cover **37** can be restricted. The reciprocating movement of the film member **40** causes toner to slide along and fall off the film member **40** into the region R between the sleeve cover **37** and the toner supply roller **30**.

Toner is temporarily accumulated around the edge of the bristle cutting blade **33** and then collected by the magnetic brush formed on the surface of the toner supply roller **30** because of the rotation of the toner supply roller **30** in a reverse direction (in a direction indicated by arrow D**5** in FIG. **8**) that is opposite to the rotation direction thereof during image formation. The toner collected by the magnetic brush passes through the gap between the toner supply roller **30** and the bristle cutting blade **33** as the toner supply roller **30** rotates. After passing through the gap between the toner supply roller **30** and the bristle cutting blade **33**, the toner is separated from the toner supply roller **30** by the action of the region of the stationary magnetic body where adjacent homopolar magnetic poles are included. Thus, toner in the region R can be effectively returned to the supplying conveyance chamber **22**. The description of the timing for driving the toner supply roller **30** to rotate in the reverse direction in the first embodiment applies to the second embodiment.

According to the present embodiment, the film member **40** reciprocates at an amplitude according to the protrusion distance of the teeth of the ratchet gears **60***a* and **60***b*. In addition, the film member **40** reciprocates at a frequency according to the number of the teeth of the ratchet gears **60***a* and **60***b*. That is, the amplitude, the frequency, and so on of the reciprocating movement of the film member **40** can be varied as appropriate by varying the protrusion distance or the number of the teeth of the ratchet gears **60***a* and **60***b*.

According to the present embodiment, the film member **40** does not oscillate during image formation. It is therefore possible to reduce toner peeling, which is an image defect that may occur when toner accumulated on the film member **40** scatters and adheres to the toner supply roller **30** or the development roller **31** during image formation.

Next, a third embodiment will be described focusing on differences thereof from the first embodiment with reference to FIGS. **11** and **12**. The third embodiment is different from the first embodiment in that the film member **40** of the third embodiment is in contact with the seal member **39**.

FIG. **11** is a perspective view of a part of the sleeve cover **37** that is used in the developing device **3***a* according to the third embodiment of the present disclosure. In the present embodiment, an upper end of the film member **40** is extended upward to be in contact with the seal member **39**. Although the idler gear **41**, the coil spring **43**, the linkage member **45**, and some other elements are not shown in FIG. **11**, the mechanism for the reciprocating movement of the film member **40** of the third embodiment is the same as that in the first embodiment. Therefore, description thereof is omitted.

According to the configuration of the present embodiment, the seal member **39** oscillates in accompaniment to the reciprocating movement of the film member **40** in the longitudinal direction. As a result, toner adhering to an inner surface (a left-front-side surface in FIG. **11**) of the seal member **39** is shaken off, slides along and falls off the film member **40**. Thus, the toner is forced back into the supplying conveyance chamber **22** (see FIG. **3**). Accordingly, accumulation of toner that has flown to the seal member **39** can be also restricted. The link arm **51** and the ratchet mechanism **60** may be used as the mechanism for the reciprocating movement of the film member **40** as in the case of the second embodiment.

The present disclosure is not limited to the above-described embodiments. Various alterations can be made thereto within the scope without departing from the essence of the present disclosure. For example, the shapes and the configurations of the sleeve cover **37** and the film member **40** described in the embodiments above are merely examples, and are not particularly limited to those described in the embodiments. They may be determined as appropriate according to the configuration of the developing device **3***a*.

For example, the first embodiment is described using the configuration in which the protrusion **50** is formed on the idler gear **41** as an example. However, the present disclosure is not limited to the aforementioned configuration. For example, the protrusion **50** may be formed on any of the other gears included in the gear train for driving the toner supply roller **30** or the development roller **31**.

The second embodiment is described using the configuration in which the ratchet gear **60***b* is disposed on the idler gear **41** as an example. However, the present disclosure is not limited to the configuration. For example, the ratchet gear **60***b* may be disposed on any of the other gears included in the gear train for driving the toner supply roller **30** or the development roller **31**.

In the above-described embodiments, the present disclosure is applied to the developing devices **3***a* to **3***d* in which only toner is transferred from the toner supply rollers **30** to the development rollers **31** before subsequently being supplied from the development rollers **31** to the photosensitive drums **1***a* to **1***d*. However, the present disclosure is not limited to the embodiments. For example, as illustrated in FIG. **12**, the arrangement of the rollers used as the development roller **31** and the toner supply roller **30** may be opposite to that of the above-described embodiments. In this configuration, the development rollers (magnetic rollers having the same configuration as the toner supply rollers **30** of the above-described embodiments) supply toner to the photosensitive drums **1***a* to **1***d*. More specifically, toner is supplied to the photosensitive drums **1***a* to **1***d* by magnetic brushes of two-component developers carried on the development rollers. In this configuration, the toner supply rollers (rollers having the same configurations as the development rollers **31** of the above-described embodiments) supply toner carried thereon to the development rollers and collect residual toner on the surfaces of the development rollers. This configuration also effectively restricts accumulation of toner coming off the development rollers **31** around the controlling blades **33** opposite to the toner supply rollers **30**.

The embodiments are described above using the tandem color printer **100** as an example. However, the present disclosure can be of course applied to other types of image forming apparatuses such as monochrome and color copiers, digital multifunction peripherals, monochrome printers, and facsimile machines.

What is claimed is:

1. A developing device comprising:

a development roller disposed opposite to an image bearing member on which an electrostatic latent image is formed, the development roller having a first axis and being configured to supply a developer to the image bearing member while rotating about the first axis;

a toner supply roller disposed opposite to the development roller, the toner supply roller having a second axis parallel to the first axis and being configured to supply a toner to the development roller while rotating about the second axis;

a controlling blade disposed opposite to the toner supply roller with a predetermined gap therebetween;

a casing configured to provide accommodation for the development roller, the toner supply roller, and the controlling blade, the casing having an inner wall portion between the controlling blade and the image bearing member, the inner wall portion facing toward the development roller;

a flexible film member disposed on the inner wall portion and elongated in a direction of the first axis, the flexible film member having ends in the direction of the first axis that are opposite to each other;

an urging member connected with one of the ends of the film member and configured to pull the film member;

a linkage member connected with the other of the ends of the film member in the direction of the first axis; and

a linkage member driving mechanism disposed on one gear of a gear train for driving the development roller or the toner supply roller, the linkage member driving mechanism being configured to intermittently drive the linkage member in accompaniment to rotation of the gear to intermittently pull the film member in a direction parallel to the direction of the first axis and opposite to a direction in which the urging member pulls the film member, so that the film member reciprocates in directions parallel to the direction of the first axis, wherein

the linkage member is supported such as to be swingable relative to the casing,

the linkage member driving mechanism includes at least one protrusion,

the at least one protrusion intermittently comes in contact with the linkage member in accompaniment to the rotation of the gear, and

the film member reciprocates at a frequency according to a number of the at least one protrusion.

2. The developing device according to claim **1**, wherein the at least one protrusion is a plurality of protrusions.

3. The developing device according to claim **1**, wherein

the linkage member driving mechanism further includes a cylindrical portion integrated with the gear,

the at least one protrusion is located on an outer circumferential surface of the cylindrical portion, and

the film member reciprocates with an amplitude according to a protrusion distance of the at least one protrusion from the outer circumferential surface of the cylindrical portion.

4. The developing device according to claim **1**, further comprising

a sheet-like seal member disposed with an edge thereof in a direction perpendicular to the first axis in contact with a surface of the image bearing member, wherein

an edge of the film member in the direction perpendicular to the first axis is in contact with the seal member.

5. The developing device according to claim **1**, wherein

the film member is disposed on the inner wall portion at an angle of inclination of no less than 55° relative to a horizontal plane.

6. The developing device according to claim **1**, wherein

the film member is formed from a material that is more resistant to toner adhesion than the inner wall portion.

7. The developing device according to claim **1**, wherein

the toner supply roller is a magnetic roller having a plurality of magnetic poles therein, and

the toner supply roller carries a two-component developer including a toner and a carrier using the plurality of magnetic poles.

8. The developing device according to claim **1**, wherein

the development roller is a magnetic roller having a plurality of magnetic poles therein, and

the development roller carries a two-component developer including a toner and a carrier using the plurality of magnetic poles.

9. An image forming apparatus comprising

the developing device according to claim **1**.

10. A developing device comprising:

a development roller disposed opposite to an image bearing member on which an electrostatic latent image is formed, the development roller having a first axis and being configured to supply a developer to the image bearing member while rotating about the first axis;

a toner supply roller disposed opposite to the development roller, the toner supply roller having a second axis parallel to the first axis and being configured to supply a toner to the development roller while rotating about the second axis;

a controlling blade disposed opposite to the toner supply roller with a predetermined gap therebetween;

a casing configured to provide accommodation for the development roller, the toner supply roller, and the controlling blade, the casing having an inner wall portion between the controlling blade and the image bearing member, the inner wall portion facing toward the development roller;

a flexible film member disposed on the inner wall portion and elongated in a direction of the first axis, the flexible film member having ends in the direction of the first axis that are opposite to each other;

an urging member connected with one of the ends of the film member and configured to pull the film member;

a linkage member connected with the other of the ends of the film member in the direction of the first axis; and

a linkage member driving mechanism disposed on one gear of a gear train for driving the development roller or the toner supply roller, the linkage member driving mechanism being configured to intermittently drive the linkage member in accompaniment to rotation of the gear to intermittently pull the film member in a direction parallel to the direction of the first axis and opposite to a direction in which the urging member pulls the film member, so that the film member reciprocates in directions parallel to the direction of the first axis, wherein

the gear rotates in a first direction for toner supply to the image bearing member by the development roller, and

the film member reciprocates both when the gear rotates in the first direction and when the gear rotates in a second direction that is opposite to the first direction.

11. A developing device comprising:

a development roller disposed opposite to an image bearing member on which an electrostatic latent image is formed, the development roller having a first axis and being configured to supply a developer to the image bearing member while rotating about the first axis;

a toner supply roller disposed opposite to the development roller, the toner supply roller having a second axis parallel to the first axis and being configured to supply a toner to the development roller while rotating about the second axis;

a controlling blade disposed opposite to the toner supply roller with a predetermined gap therebetween;

a casing configured to provide accommodation for the development roller, the toner supply roller, and the controlling blade, the casing having an inner wall portion between the controlling blade and the image bearing member, the inner wall portion facing toward the development roller;

a flexible film member disposed on the inner wall portion and elongated in a direction of the first axis, the flexible film member having ends in the direction of the first axis that are opposite to each other;

an urging member connected with one of the ends of the film member and configured to pull the film member;

a linkage member connected with the other of the ends of the film member in the direction of the first axis; and

a linkage member driving mechanism disposed on one gear of a gear train for driving the development roller or the toner supply roller, the linkage member driving mechanism being configured to intermittently drive the linkage member in accompaniment to rotation of the gear to intermittently pull the film member in a direction parallel to the direction of the first axis and opposite to a direction in which the urging member pulls the film member, so that the film member reciprocates in directions parallel to the direction of the first axis, wherein

the linkage member includes a link arm that reciprocates in the directions parallel to the direction of the first axis,

the linkage member driving mechanism includes a first ratchet gear and a second ratchet gear in meshing engagement,

the link arm supports the first ratchet gear such that the first ratchet gear is rotatable only in a first direction,

the second ratchet gear rotates in the first direction and in a second direction that is opposite to the first direction according to the rotation of the gear,

the first ratchet gear and the second ratchet gear in meshing engagement integrally rotate in the first direction while the gear is rotating in the first direction,

the first ratchet gear slides relative to the second ratchet gear to reciprocate in the directions parallel to the direction of the first axis while the gear is rotating in the second direction, and

the first ratchet gear reciprocating in the directions parallel to the direction of the first axis causes the link arm to reciprocate in the directions parallel to the direction of the first axis.

12. The developing device according to claim **11**, wherein the film member reciprocates with an amplitude according to a profile of teeth of the first ratchet gear and the second ratchet gear.

13. The developing device according to claim **11**, wherein the film member reciprocates at a frequency according to a number of teeth of the first ratchet gear and the second ratchet gear.

* * * * *